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THE MANUFACTURE OF MOZZARELLA CHEESE FROM RECONSTITUTED NONFAT DRY MILK SOLIDS

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Storage of U.S. Government surpluses of nonfat dry milk (NDM) is approaching 700 million pounds. The costs of storage and deterioration of quality over prolonged periods represent a significant financial loss to the American public. Although a portion of the NDM can be purchased and used in baked goods and confectionary goods, a sizable quantity will not be used, especially if milk production remains high. As an approach to alleviating the surplus of NDM, we conducted research on the suitability of manufacturing certain cheeses from reconstituted NDM. While Cottage, Colby, Muenster, and Cheddar have all been manufactured by us, we will limit our comments to the manufacture of Mozzarella.

The first studies on Mozzarella were designed to produce a cheese with high moisture (>50%) and low fat (18% or less). This composition could easily be achieved by manufacturing the cheese as shown in Figure 1. It is imperative that high quality low heat NDM be used in the manufacture of Mozzarella. When as little as 12% of the low heat NDM is replaced by high heat NDM, the curd lacks stretch and melt characteristics and has a grainy texture. Coagulation of the reconstituted low heat NDM by animal or microbial rennet is normal without the addition of calcium chloride. A lower pH, 5.05 - 5.10, is also necessary for the NDM cheese to have good stretch characteristics. The reason for this is unclear, except that a small amount of denatured whey protein on the casein particles could interfere with the typical elasticity and stretch of cheese that is obtained at pH 5.15 - 5.20 with fresh milk.

The high moisture cheese made by the above procedure shreds remarkably well. Some of our studies have shown that when NDM Mozzarella is frozen for as long as 6 - 9 months, the thawed product still retained much of its good quality. Commercial production and industrial freezing of a high moisture cheese could yield different results.

Mozzarella cheese manufactured by the above method has been evaluated by at least six different commercial firms. The consensus was that flavor, color, and meltability were all acceptable. Occasionally, the body characteristics have been criticized as "weak", and, in one instance, the shredability was unacceptable. In very high moisture cheese, a gummy body would be accepted. Therefore, to optimize conditions, a moisture content of 46 - 50% would be more ideal for proper body and shredability of the product.

The manufacture of Eastern Type Mozzarella, where direct-to-the-vat lactic cultures have replaced "cocci" and "rods", has yielded excellent quality cheeses with moisture contents above 55% (Table 1). With this cheese, the curd is not cooked but is maintained at 35°C (95°F) throughout the stir-out operation. The nonheating of the curd results in higher moisture cheeses.

Yields of cheese based upon the total pounds of NDM added ranged from 1 - 1.2 lbs. cheese/lb. NDM. While the percent moisture in the cheese affects yield, at 46 - 48% moisture one pound of NDM produces one pound of Mozzarella.

All of our research on the manufacture of Mozzarella cheese was performed on 200 gallon lots of milk; the curd was conventionally cheddared; and stretching and molding were done either by hand or by using the facilities of a local Italian cheese manufacturing plant. Scaling up the procedure to large commercial vats and molding equipment has been done by several industries. However, the manufacture of the cheese from NDM has not yet, to our knowledge, been performed on automated equipment. Therefore, the cheese maker must adjust conditions of cooking, pH of stretching, and molding, depending on the equipment used. For example, acid development is faster because the starter microbex grow more rapidly on heat denatured proteins (more peptides, more amino acids) from reconstituted NDM than from fresh milk. Adjustment of moisture to 46 - 50% can be obtained by raising the cooking temperature to 42 - 45°C and by holding in the whey for longer periods. It appears certain that very close control of NDM Mozzarella can be obtained regardless of the manufacturing procedure and that, because of controlled composition upon reconstitution, a more uniform cheese could be made daily.

The use of NDM in the manufacture of excellent quality Mozzarella is a practical approach to the partial utilization of U.S. Government surplus stocks. Cheese made from NDM can be distributed through state and Federal school lunch programs. In areas of milk shortage, the cheese can be manufactured on location, thereby reducing the costs of shipment, a large part of which is water. Perhaps foreign markets could be established for sale of NDM Mozzarella providing, as it does in our domestic sales, a valuable source of protein and fats.

Table 1. Composition of Commercial Mozzarella* Cheese and Those
Manufactured from Reconstituted NDM and Cream (this study)

Analysis	Commercially manufactured			This study				
	A	B	C	1	2	3	4**	5**,***
Moisture (%)	46.5	50.0	51.7	50.1	50.1	52.4	51.4	56.6
Fat (%)	18.0	15.0	17.0	16.0	16.5	17.0	17.0	14.75
Salt (%)	1.95	1.42	1.53	1.0	1.1	1.0	1.5	1.35
pH	5.31	5.27	5.23	5.45	5.33	5.28	5.22	5.22

* Part-skim Mozzarella.

** Manufactured with Marschall Superstart.¹

*** Manufactured from hydrolyzed lactose milk.

¹The mention of commercial items is for your convenience and does not constitute an endorsement by the Department of Agriculture over other items of similar nature not mentioned.

Figure 1. Manufacture of Mozzarella Cheese from Reconstituted NDM

